Major Salivary Glands: Sonographic Anatomy and Pathologic Conditions

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Learning objectives

1. To provide a comprehensive review of the anatomy of the salivary glands, as studied by us.

2. To overview the spectrum of the pathologic conditions that may affect the salivary glands, with emphasis on the role of us.

Background

Anatomy

Parotid gland

The parotid gland is the largest salivary gland and is bounded anteriorly by the ascending ramus of the mandible and posteriorly by the mastoid process (5). It has a deep extension that runs medially behind the mandible toward the pterygoid fossa. The facial nerve enters the fat-rich parotid gland below the stylomastoid foramen and divides into two or three main branches. The excretory duct of the gland, passes over the masseter and through the buccinator, and opens into the upper part of the oral vestibule at the level of the second upper molar(1,2).

Submandibular gland

The submandibular gland is located between the mandible and digastric muscle and is bounded deeply by the mylohyoid. Its excretory duct, the submandibular duct, passes around the posterior border of the mylohyoid, turns forward medial to the sublingual gland. (1,2)

Sublingual gland

The sublingual gland is located in the floor of the mouth, medial to the mandible, cranial to the mylohyoid muscle, and lateral to the geniohyoid muscle. The sublingual gland often has multiple small excretory ducts, which are not visible with ultrasound, and sometimes the duct is connected with Wharton duct.(3)

Findings and procedure details

Pathologic conditions
**Congenital lesions**

One or more salivary glands and their excretory ducts may be aplastic. Congenital cystic changes most commonly involve the parotid gland. Three types of congenital cystic lesion are distinguished: branchial arch cysts (fig.1), lymphoepithelial cysts, and dermoid cysts (1,2).

**Inflammatory diseases**

**Acute inflammation**

Acute inflammatory diseases include viral parotitis or may result from impaired salivary outflow due to sialolithiasis (fig.2,3). Bacterial infections are common among the older population and postsurgical patients, as well as in cases of obstructive diseases of the duct system like stone or strictures. An acute infection can lead to the formation of an abscess (fig.4,5)(3). The US features include enlarged and hypoechoic salivary glands with increased blood flow; they may contain multiple small, oval, hypoechoic areas (fig.2,3,6). In some cases enlarged endoparotid lymph nodes are visualized (fig.7). Lymph nodes can be found in parotid glands and not in the other salivary glands, as this one encapsulates late in the 2nd trimester and it incorporates lymphatic tissue (6).

**Chronic inflammation**

Chronic inflammatory diseases of the salivary glands result from recurrent bouts of acute inflammation, which may lead to atrophy and replacement by fibrotic tissue, and are also commonly associated with granulomatous processes. The salivary glands are normal sized or smaller, hypoechoic, and inhomogeneous (fig.8)(1,2). In children, chronic recurrent cystic sialadenitis is an atypical form of chronic inflammation in which multiple hypoechogenic, cystoid areas in the parotid glands are caused by peripheral ductal ectasias and is visualized sonographically (3).

**Sialolithiasis**

Appears as markedly hyperechoic lines or points with distal acoustic shadowing (fig.2,3). The submandibular gland is involved in 80%-90% of cases and the parotid gland in about 10% (3).

**Sialosis**

Appears as enlarged hyperechoic glands without focal lesions or increased blood flow and can be caused by systemic disorders such as diabetes mellitus, alcoholism, hypothyroidism, and malnutrition (6).

**Systemic disorders of the major salivary glands**
In the category of systemic disorders that may affect the major salivary glands, there are a number of autoimmune diseases, HIV related cysts and nodules, Sjogren syndrome, and Sarcoidosis.

Sjogren syndrome is an autoimmune disease that attacks exocrine glands and is characterized by lymphocytic infiltration of the glandular parenchyma. The US features of this entity include inhomogeneous salivary glands with scattered small, oval, hypoechoic or anechoic areas, usually well defined, and increased parenchymal blood flow (fig.9) (1,2). Sjogren syndrome increases the risk of parotid lymphoma by more than 4,400%. Therefore, any mass in a Sjogren parotid gland must be further investigated with aspiration or biopsy.

Neoplastic Diseases

Acquired cysts

Salivary gland cysts have well-defined margins, anechoic contents, posterior acoustic enhancement, and no internal blood flow. They usually result from duct obstruction by a stone, inflammatory stricture or trauma, giving rise to a retention cyst. The submandibular gland is more commonly affected.

A retention cyst in the sublingual gland is called ranula (fig.10). A diving ranula results from rupture of the ranula wall and forms a pseudocyst that extends into the submental space through a gap in the mylohyoid (1,2).

Benign neoplasms

Pleomorphic adenomas (or mixed tumor)

They are usually hypoechoic, well-defined, lobulated lesions with posterior acoustic enhancement that may contain calcifications (fig.11). It is the most common salivary gland tumor and is usually manifested in the parotid gland (2). Pleomorphic adenomas have the potential for malignant degeneration and a tendency to recur if the capsules are damaged at surgery. For that reason, partial or total parotidectomy should be performed (5,6).

Warthin’s tumor

Cystadenolymphoma is the second most common benign tumor of the parotid gland. The multiplicity and location at the tail of the parotid gland (near the lower mandible) are typical features of this tumor (6). Sonographically (fig.12,13), the lesion is usually more inhomogeneous than the pleomorphic adenoma, presenting with cystic parts within a solid lesion with posterior acoustic enhancement and is often hypervascularized (3).

Rare benign tumors

This category includes adenomas, cystadenomas, hemangiomas, lymphangiomas, lipomas and neurogenic tumors.
Malignant neoplasms

Malignant neoplasms of the salivary glands may have irregular shapes, irregular borders, blurred margins, and a hypoechoic inhomogeneous structure or may have a benign appearance (fig.14,15). They include adenocarcinoma, mucoepidermoidcarcinoma, adenoid cystic carcinoma, squamous cell carcinoma and metastases. The most common malignant neoplasms occurring in salivary glands are mucoepidermoid carcinoma and adenoid cystic carcinoma (1). Tumors smaller than 2 cm in diameter usually have a homogeneous structure, smooth borders and can be misinterpreted as benign lesions (4).

Effects of Irradiation

The major salivary glands are often irradiated during radiation therapy of head and neck neoplasms. A major adverse effect of such treatment is xerostomia caused by functional and structural impairment of salivary parenchyma. The salivary glands enlarge in the acute phase and later become smaller because of atrophy. After irradiation, salivary glands become hypoechoic and inhomogeneous at US (1).

Trauma

Traumatic injuries of the salivary glands occur most often in the parotid gland. US may demonstrate a hematoma, or other fluid collections (eg, a sialocele). Suspected damage to the facial nerve or Stenonduct requires further investigation with other imaging modalities (CT, MR, sialography) (1).

Images for this section:

Fig. 1: Branchial arch cyst in the right parotid gland Gray-scale US image shows a cystic lesion in right parotid gland with fluid-fluid level (yellow arrows). Power doppler US image shows the absence of vascularity of this cystic lesion. Note the adjacent small lymph node (purple arrow).
Fig. 2: US image shows a sialolith in the inflamed parenchyma of the left submandibular gland, which appears hypoechoic and inhomogeneous. The intraglandular excretory duct above the stone is dilated.

Fig. 3: The right parotid gland is enlarged, inhomogeneous and with increased blood flow. There is a mild dilatation of its ducts due to the presence of small stones (arrows) with diameter about a few millimeters long each of them.
**Fig. 4:** The right parotid gland is enlarged and inhomogeneous with an hypoechoic lesion with unclear borders. The central liquefaction of the abscess is distinguished as an avascular area with debris inside.

**Fig. 5:** The left submandibular gland is enlarged and inhomogeneous with an hypoechoic lesion with unclear borders. The central liquefaction of the abscess is distinguished as an avascular area with debris inside.

**Fig. 6:** Gray-scale US image shows an acutely inflamed right parotid gland. The gland is enlarged and inhomogeneous with multiple small, oval, hypoechoic areas. Color doppler us image shows increased blood flow.
Fig. 7: US image depicts an intraparotid lymph node.

Fig. 8: Chronic inflammation of submandibular glands which are slightly smaller, hypoechoic, and inhomogeneous and do not have increased blood flow.

Fig. 9: Sjogren syndrome: The gland has an inhomogeneous structure with multiple small, oval, hypoechoic areas. These imaging features can also be observed and in a variety of other pathologic conditions such as sarcoidosis or other granulomatous diseases even in acute or chronic inflammation.
**Fig. 10:** Simple ranula of the right sublingual gland imaged with US and MR. A retention cyst in the sublingual gland is called a ranula.

**Fig. 11:** Gray-scale US image shows the typical appearance of a pleomorphic adenoma of the parotid gland. The lesion is hypoechoic and lobulated with distinct borders and posterior acoustic enhancement. A blood vessel is barely visible in the lesion.
Fig. 12: Gray-scale US image shows the typical appearance of a Warthin tumor. The lesion, which is located in the lower pole of the parotid gland, is oval, well defined, hypoechoic, and inhomogeneous with several irregular anechoic areas and posterior acoustic enhancement. Color doppler US image shows the increased vascularity of the tumor.
Fig. 13: Gray-scale US image shows the typical appearance of a Warthin tumor. The lesion, which is located in the lower pole of the parotid gland, is oval, well defined, hypoechoic, and inhomogeneous with multiple irregular anechoic areas and posterior acoustic enhancement.

Fig. 14: Gray-scale US image shows the typical appearance of a malignant salivary neoplasm (in this case adenocarcinoma). The lesion presents as a hypoechoic
inhomogeneous structure with an irregular shape and borders and blurred margins. The presence of multiple scattered hyperechoic foci arise the suspicion of microcalcifications in this malignant lesion.

Fig. 15: Gray-scale and color doppler US image shows a rare malignant salivary neoplasm (Merkel cell neuroendocrine carcinoma). The lesion presents as a hypoechoic inhomogeneous structure with an irregular, lobulated shape and borders and internal blood flow.
Conclusion

1. US is a method of high sensitivity and specificity in defining pathology involving the salivary glands.

2. US guidance can also be used for diagnostic FNA in cases where US appearances are inconclusive as imaging findings in some diseases may overlap.

3. The limitations of US include its inability to evaluate deep parotid masses, lesions obscured by the mandible, parapharyngeal extension, retropharyngeal and deep neck adenopathy, and the intracranial or skull base extent of a mass(6).

Personal information

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